Specification

WORK PROCESSING METHOD IN MACHINE TOOL, PROCESSING JIG FOR PERFORMING THE METHOD, AND SUPPORT DEVICE FOR WORK PROCESSING

Technical Field

The present invention relates to a work processing method in a machine tool, a processing jig for performing the method and a support device for the work processing.

Description of the Prior Art

There exists a machine tool, wherein a main shaft movable at least in a longitudinal direction is provided at a position on one side of a horizontally longitudinal direction of a foundation (for example, see Japanese Patent Gazette of Japanese Provisional Publication No. 2001-9652).

In the machine tool, a work grip rotation feed mechanism portion for rotating a work about a specific lateral axis is provided to a position relating to the main shaft, and the work griped thereby is processed by being fed and rotated to a specific angle position about the specific lateral axis (for example, see Japanese Patent Gazette of Patent No. 3083776).

In this processing, when a bar-like work is moved from one of either positions to the other between the case where it is attached to and removed from the work grip rotation feed mechanism portion and the case where it is processed by the operation of the main shaft, the work grip rotation feed mechanism portion is not moved on the foundation.

In processing the bar-like work without moving the work grip rotation feed mechanism portion to a main shaft direction on the foundation as the above mention, when the bar-like work is attached to and removed from the work grip rotation feed mechanism portion, a worker can not enough approach it. In addition, the work grip rotation feed mechanism portion is too near to the main shaft to secure an operation space. Owing to this, the bar-like work contacts with a tool fixed

to the main shaft, damaging these together. Besides, in processing the griped bar-like work, since a distance between the tool fixed to the main shaft and the work at a processing start position is large, the main shaft needs to be displaced against the bar-like work on a large stroke. This is sometimes at a disadvantage on the processing efficiency. The present invention aims to settle these problems.

Summary of the Invention

In the first invention, in a machine tool having a main shaft movable in at least a specific horizontal direction at a position on one side of a foundation (a bed 1), a vertical rotation support shaft is provided at a position on the other side of the foundation, and a lateral stand having a slanting surface with a fixed angle is fixed on the top portion of the vertical rotation support shaft, and a work grip rotation feed mechanism portion for rotating a bar-like work is provided on the slanting surface. Here, when the slanting surface sits opposite to the main shaft, it is gradually descending thereto so as to form the fixed angle. An axis of the vertical rotation support shaft is horizontally separated from that of the work grip rotation feed mechanism portion by a required distance. The position of the lateral stand is varied by rotating the vertical rotation support shaft between the case where the bar-like work is attached to and removed from the work grip rotation feed mechanism portion and the case where it is processed by longitudinally displacing the main shaft.

In the present invention, when the bar-like work is attached to and removed from the work grip rotation feed mechanism, the lateral stand is deflected to the other side against the vertical rotation support shaft to separate from the main shaft. According to this, the worker can easily approach the work grip rotation feed mechanism from the other side. Besides, since an interval between the vertical rotation support shaft and the main shaft becomes large, a space for attaching and removing a bar-like work is enlarged.

On the other hand, when processing the bar-like work griped by the work grip rotation feed mechanism portion, the lateral stand is deflected to the one side against the vertical rotation

support shaft to approach the main shaft. According to this, since a distance from the main shaft to the work at the processing start position becomes small, the bar-like work can be processed on a small stroke.

In the second invention, an axis of the vertical rotation support shaft and an axis of the work grip rotation feed mechanism portion are arranged so that the latter can separate toward the main shaft when the lateral stand sits opposite to the main shaft.

In the third invention, a slanting surface of the lateral stand is inclined against a horizontal plane by an angle of 15 degrees or more.

In the forth invention, a support device for work processing is so constructed that in a machine tool having a main shaft movable at least in a longitudinal direction at a position on one side of a horizontally longitudinal direction of a foundation, a vertical rotation support shaft is provided at a position on the other side of the foundation, and a lateral stand having a slanting surface with a fixed angle is fixed on the top portion of the vertical rotation support shaft, and a work grip rotation feed mechanism portion for rotating a bar-like work is provided on the slanting surface. Here, when the slanting surface sits opposite to the main shaft, it is gradually descending thereto. Besides, an axis of the vertical rotation support shaft is horizontally separated from that of the work grip rotation feed mechanism portion by a required distance. And, the position of the lateral stand is varied by rotating the vertical rotation support shaft between the case where the bar-like work is attached to and removed from the work grip rotation feed mechanism portion and the case where it is processed by longitudinally displacing the main shaft.

In the forth invention, the upper surface of the lateral stand is inclined by an angle of 15 degrees or more.

According to this, even if cutting chips due to processing drop on the upper surface of the lateral stand, they are flowed down together cutting fluid by self-weight due to flow action of the cutting fluid.

Besides, in the invention, it may as well to form the lateral stand from a horizontal bottom surface portion, a standing surface portion stood from one end of the bottom surface portion, and a

slanting surface portion arranged between the bottom surface portion and the standing surface portion, and besides, to arrange required members such as cables and pipes for the work grip rotation feed mechanism portion in a space surrounded by the bottom surface portion, the standing surface portion and the slanting surface portion.

According to this, as same as the case of the third invention, the lateral stand can improve in rigidity due to increasing section modulus and guard the required members such as the cables and the pipes.

Brief Description of the Drawings

Fig. 1 is a partially sectional side view showing a state that a machine tool related to the present invention is used. Fig. 2 is a plane view showing the using state.

Fig. 3 is a sectional view taken along x1—x1 after a work is removed in Fig. 5.

Fig. 4 is a side view showing a state that the machine tool processes the work, and Fig. 5 is a plane view thereof.

Fig. 6 is a side view of a modification of these for comparing with a work grip rotation feed mechanism portion and a lateral stand of the machine tool.

Preferred Embodiment of the Invention

The present invention will be explained particularly with reference to the drawings.

In Figs. 1 to 3, 1 is a bed, and thereon, a fixed-type column 2, a work processing jig device 3, a numerical control mechanism 4 and a hydropneumatic equipment 5 are provided.

The column 2 is fixed at a position on one side of the bed, having a cylindrical spindle housing 7 rotatively supporting a longitudinal (Z-axial) main shaft 6 mounted displaceably in an X-axial direction, a Y-axial direction and a Z-axial direction forming orthogonal triaxial directions. A tool 8 is fixed on the front end of the main shaft 6.

The processing jig device 3 is mounted on the other side of the bed 1, comprising a servomotor 9, a vertical rotation support shaft 10 in a Y-axial direction, a horizontal rotating table 11,

a lateral stand 12, and a work grip rotation feed mechanism portion 13. Here, the servomotor 9 is provided in the bed 1, and the rotation support shaft 10 is rotatively supported at a specific position on the bed 1 to be rotated by the servomotor 9. The rotating table 11 is fixed on the top portion of the rotation support shaft 10, and the lateral stand 12 is horizontally fixed on the upper surface of the rotating table 11 and shaped in rectangular from a plane view. The feed mechanism portion 13 is provided on the upper surface of the lateral stand 12.

In this case, the lateral stand 12 has a right-angled-triangle-shaped section as shown in Fig. 3, comprising a horizontal bottom surface portion 12a, a standing surface portion 12b and a slanting surface portion 12c. Here, the bottom surface portion 12a is fixed on the rotating table 11, the standing surface portion 12b is stood from one end of the bottom surface portion 12a, the slanting surface portion 12c is arranged between these surface portions 12a, 12b, and the upper surface of the slanting surface portion 12c is inclined against a horizontal surface by an angle of 15 degrees or more. In the illustrated examples, the upper surface of the slanting surface portion 12c is inclined by an angle of about 35 degrees. A closable space a is formed by the bottom surface portion 12a, the standing surface portion 12b and the slanting surface portion 12c.

The feed mechanism portion 13 comprises a work feed driving portion 13a fixed at a position on one end of the lateral stand 12 and a tale stock 13b fixed at a position on the other end thereof. The feed driving portion 13a comprises a standing support stand 15, a chuck portion 16 and a driving side center 17, fixed on the upper surface of the slanting surface portion 12c. The support stand 15 has a NC (numerical control) table 14 to the side portion thereof. The chuck portion 16 is fixed concentrically with the NC table 15, rotating around a specific lateral axis S on the support stand 15. The driving side center 17 is supported by the support stand 15, arranged on the lateral axis S so as to support a rotation center of one end surface of a work griped by the chuck portion 16.

In this case, the lateral axis S is separated from the support shaft 10 by a required distance L0 in a Z-axial direction. According to the distance L0, a bar-like work w can be easily attached to and removed from the feed mechanism portion 13, and therefore, the bar-like work w griped by

the feed mechanism portion 13 is efficiently processed. This is obvious from the later explanation. The lateral axis S portion between the driving portion 13a and the tale stock 13b is separated from the upper surface of the lateral stand 12 by a distance L1 (see Fig. 3). The distance L1 is a specific size required to rotate the predetermined maximum bar-like work on the upper surface of the lateral stand 12.

The chuck portion 16 is provided with a plurality of claws 16a for griping the bar-like work w displaceable in a radial direction of a chuck body portion on the lateral axis S. And therein, two axial positioning members 16b each having a radial surface b for determining a position of the bar-like work w on an X-axial direction are fixed on the chuck body portion.

The tale stock 13b comprises a standing support stand 18 fixed on the upside of the slanting surface portion 12c of the lateral stand 12, an X-axial driving device 18a mounted thereon, and a push center 19. The push center 19 is slidably-displaceably supported to the support stand 18 and pressed by the X-axial driving device 18a to support the rotation center of the other end surface of the bar-like work w.

As shown in Fig. 3, cables 20, pipes 21 and tubes, which are members necessary to operate the driving portion 13a and the tale stock 13b, are arranged in the space a of the lateral stand 12. These members 20, 21 are guided into the bed 1 through the inside of the rotating table 11 from the bottom surface of the lateral stand 12 so as not to be exposed to a space for processing the work on the bed 1, and connected to a required portion.

A using example of the case where a crankshaft as a bar-like work w is processed by this machine tool will be explained with reference to Figs. 4 to 6.

In loading the crankshaft w to be processed in the feed mechanism portion 13, the lateral stand 12 is positioned as shown in Fig. 1 and Fig. 2. According to this, the lateral axis S is deflected to the front side of the Z-axial direction against the support shaft 10. Under the state, a worker c approaches the feed mechanism portion 13 from the front side f1 of the bed 1, arranging the crankshaft w between the driving side center 17 and the push center 19 by manual operation or a robot, then displacing the push center 19 to the driving side center 17 by the operation of the

driving device 18a, interfitting these 17, 19 into each of center holes formed to end surfaces of the crankshaft w to put the crankshaft w into these 17, 19 as well as to press to the radial surface b of the axial positioning member 16b. According to this, the driving side center 17 and the push center 19 support the crankshaft w at a specific position on the lateral axis S. Thereafter, according to displacing the claws 16a of the chuck portion 16, the outer surface of an axial portion of one end of the crankshaft w is griped by the claws 16a, and in this way, loading for the crankshaft w is finished.

In this loading operation, the feed mechanism portion 13 is displaced close at hand of the worker c in comparison with the case where the rotation support shaft 10 agrees with the lateral axis S. Accordingly, the worker c can fix the crankshaft w to the feed mechanism portion 13 precisely and fatiguelessly. In addition, the feed mechanism portion 13 is separated from the tool 8 fixed on the main shaft 6 in comparison with the case where the rotation support shaft 10 agrees with the lateral axis S. Accordingly, since a space for loading the crankshaft w from the tool 8 is secured broad, the crankshaft w does not carelessly contact with the tool and the like.

Next, the main shaft 6 is climbing-rearward displaced to a height so that the tool 8 can not interfere with the feed mechanism portion 13. Under this state, the servomotor 9 is operated so as to rotate the lateral stand 12 around the rotation support shaft 10 by an angle of 136 - 225 degrees and agree the lateral axis S with the X-axial direction as shown in Fig. 4 and Fig. 5. According to this, the lateral axis S is deflected to the rear side f2 of the Z-axial direction against the rotation support shaft 10. Then, the numerical control mechanism portion 4 is operated so as to decide a phase of the crankshaft w around the lateral axis S. And thereafter, the main shaft 6 is rotated by the operation of the numerical control mechanism portion 4, and besides, the position of the crankshaft w around the lateral axis S and the position of the main shaft 6 are regulated to process the crankshaft w.

In this processing of the crankshaft w, a distance L3 between the tool 8 and the crankshaft w at the processing start position is short in comparison with the case where the rotation support shaft 10 agrees with the lateral axis S. Therefore, since a stroke of the main shaft 6 in the Z-axial

direction, which is required to process the crankshaft w, is shortened, the crankshaft w can be efficiently processed.

Strains about the feed mechanism portion 13 and the lateral stand 12 while the crankshaft w is cutting will be explained with reference to Fig. 3 and Fig. 6.

In cutting the crankshaft w, the tool 8 is pressed to it. In this case, when a power for pressing the tool 8 shown in Fig. 3 is made F1, the power F1 assigns a bending power M1 to the work driving portion 13a and the bottom surfaces of the support stands 15, 18 of the tail stock 13b. Here, the bending power M1 is indicated as the following Formula (1).

That is;

$$M1 = F1 \times L1 \times \cos\theta \quad \cdots\cdots \quad \text{Formula (1)}$$

As shown in Fig. 6, in case the upper surface of the lateral stand 12 forms a horizontal surface and a distance between the horizontal surface and the lateral axis S is made L1, a bending power M2 that the pressing power F1 assigns to the bottom surfaces of the support stands 15, 18 is indicated as the following Formula (2).

That is;

$$M2 = F1 \times L1 \quad \cdots\cdots \quad \text{Formula (2)}$$

Obviously from this, when the upper surface of the lateral stand 12 is inclined, the bending power assigned to the bottom surfaces of the support stands 15, 18 becomes small in comparison with the case where the lateral stand 12 forms a horizontal surface as shown in Fig. 6. Therefore, a strain of the feed mechanism portion 13 during processing becomes small that much.

Since there is a space in the sectional shape of the lateral stand 12, a polar modulus of section against the center of the section thereof becomes large in comparison with the case where there is no space on the same materials and the same weight. Therefore, the rigidity of the lateral stand 12 is increased, and a torsion strain due to the bending power M1 comes to be reduced.

Lastly, it is referred to the cutting chips while the crankshaft w is cut. Although the cutting chips drop on the upper surface of the lateral stand 12 during the cutting, since the upper surface is inclined by an angle of 15 degrees or more, the dropped cutting chips are assisted by flow

of cutting fluid and surely drop on the upper surface of the bed 1.

In case the upper surface of the lateral stand 12 is inclined by an angle of about 35 degrees as the example of the present invention, the cutting chips can drop on the upper surface of the bed 1 by self-weight without the assistance by the flow of the cutting fluid.

INDUSTRIAL APPLICABILITY

According to the present invention, the following effects can be made. Since the work grip rotation feed mechanism portion is deflected to the worker against the rotation support shaft when the bar-like work is attached to and removed from it, the worker can easily approach it to load the bar-like work precisely and fatiguelessly. In addition, since a distance between the work grip rotation feed mechanism portion and the main shaft is large, the space for attaching and removing the bar-like work is enlarged. Accordingly, it is possible to easily load the bar-like work, and to prevent from a careless contact between the bar-like work and the tool fixed on the main shaft.

On the other hand, in processing the work griped by the work grip rotation feed mechanism portion, since the lateral sand is deflected to the main shaft side against the rotation support shaft, the distance between the main shaft and the work at the processing start position is small. Therefore, it is possible to process the work by the small stroke on the Z-axial direction and improve the processing efficiency.

In addition, it is possible to flow down the cutting chips dropped on the upper surface of the lateral stand by the self-weight with the cutting fluid. Moreover, it is possible to decrease a bending power that acts on the work grip rotation feed mechanism portion and the lateral stand due to a simple structure while the work is processed.

In case a particular slope guide plate for guiding the cutting chips to the upper surface of the lateral stand is not provided, the dropped cutting chips are dropped outside the lateral stand with assisted by the flow of the cutting fluid or without the assistance.

It is possible to improve the rigidity of the lateral stand by few materials and make the lateral stand secure the required members such as cables and pipes.